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Case Report

Cutting balloon and high-pressure balloon dilation for palliative treatment of congenital double-chambered right ventricle and primary infundibular stenosis in a Golden retriever dog☆

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Abstract Combined cutting balloon and high-pressure balloon dilation was performed in a dog with a double-chambered right ventricle and severe infundibular stenosis of the right ventricular outflow tract. The peak systolic pressure gradient across the stenosis decreased by 65% after dilation (from 187 mmHg before to 66 mmHg after) affirming the intervention as successful. However, early re-stenosis occurred within 3 months leading to exercise intolerance, exercise-induced syncope, and right-sided congestive heart failure. Cutting balloon followed by high-pressure balloon dilation provided temporary but not long-term relief of right ventricular obstruction in this dog.

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Abbreviations

DCRV	double-chambered right ventricle
Fr	French
IS	infundibular stenosis
IVS	interventricular septum
RA	right atrial
RV	right ventricular

A 5-month-old intact male golden retriever dog was referred to the Veterinary Medical Center at the Ohio State University for the evaluation of a loud systolic heart murmur that was identified during a puppy examination three months earlier. The owner reported that the dog was healthy. At examination, the dog was bright and alert, with a body weight of 17 kg (body condition score of 3/5), and a heart rate of 140 bpm. Cranial and caudal mucous membranes were pink, lung auscultation unremarkable, the heart rhythm regular, and the femoral pulses strong and synchronous. A 5/6 left-basilar holosystolic heart murmur with point of maximum intensity over the pulmonary valve area was detected. The remainder of the physical examination as well as a complete blood cell count was unremarkable. Thoracic radiography indicated that the cardiac silhouette was within the reference range with a vertebral heart size of 10.4 (right lateral view; upper range of reference range, 10.5) with normal appearing of great vessels and lung parenchyma. On echocardiography,[c] left heart dimensions and function were unremarkable. The right atrium was moderately enlarged, with the interatrial septum bulging toward the left atrium but otherwise seemed intact. The interventricular septum (IVS) at the right ventricular (RV) inflow tract was bulging into the left ventricle in systole and was flat in diastole. The RV inflow tract was moderately to severely concentrically hypertrophied, whereas the RV outflow tract appeared thin-walled and mildly dilated (*see* Table 1 for measurements). There was severe, discrete obstruction of the right ventricle on two-dimensional imaging with associated flow turbulence on color flow (Fig. 1 and supplemental videos 1 and 2). This obstruction was located at the level of the supraventricular crest, in the subinfundibular region of the right ventricle, approximately 28 mm proximal to the pulmonary valve and 15 mm distal to the tricuspid valve and was best visualized from a right parasternal short-axis view. Peak flow velocity across the lesion was 6.84 m/s resulting in an estimated peak systolic pressure gradient between the inflow tract and outflow tract of 187 mmHg, using the modified Bernoulli equation. Diameter of the stenotic lesion on two-dimensional imaging was approximately 4.8 mm. Strands of soft tissue originating from the IVS and attaching proximally to the obstruction were observed. Using three-dimensional echocardiography,[d] a circular lesion with well-demarcated rims and a diameter between 5 and 6 mm was identified (Fig. 1C) when 'looking down' from the pulmonary valve side (distal RV outflow tract) toward the obstruction. There was mild tricuspid regurgitation at 6.95 m/s (supplemental video 2), indicating severely elevated afterload of the right ventricle. The pulmonary valve and the main pulmonary artery appeared normal. An intravenous contrast study with agitated saline did not identify any intracardiac shunt.

Table 1 Two-dimensional and Doppler echocardiographic data acquired before and 1 day after balloon dilation.

Variable	Balloon dilation	
	Before[a]	After[a]
Heart rate (bpm)	103	96
RAD (mm)	36	34
RVD proximal chamber (mm)	19	21
RVD distal chamber (mm)	27	34
RVFW proximal chamber (mm)	10.6	10.2
RVFW distal chamber (mm)	3.6	3.5
Vmax at stenosis (m/s)	6.84	4.07
Peak RV systolic pressure gradient (mmHg)	187	66
Dimension of infundibular stenosis (mm)	4.6	8.6
Dimension of the PV	18.8	18.7
Infundibular stenosis/PV ratio	0.24	0.46
Vmax TR (m/s)	6.95	4.15
Peak RA-RV pressure gradient (mmHg)	193	69

Abbreviations: RAD, maximum right atrial dimension; RVD, right ventricular dimension; RVFW, right ventricular free wall; Vmax, peak Doppler flow velocity; PV, pulmonary valve; TR, tricuspid regurgitation.

[a] The dog was not on any inotropic medication at the time of study.

The presumptive diagnosis of mid-RV obstruction was made with the differential diagnostic considerations of double-chambered right ventricle (DCRV) and primary infundibular stenosis (IS). The former was supported by the finding of muscle bundles or similar soft tissue structures obstructing the RV at its mid-level, whereas the

[c] Vivid E9 with XDclear, GE Medical Systems, Waukesha, WI, USA.

[d] 4V-D 4D cardiac sector probe, GE Medical Systems, Waukesha, WI, USA.

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